Forest Practices Adaptive Management Science Conference

February 24th, 2004, OB-2 Auditorium

Olympia, WA

9:00 a.m. – 5:00 p.m.

Agenda

Time	Topic	Presenter
9:00	**Introduction** - The Washington Forest Practices Research and Monitoring Program	**Timothy Quinn and Doug Martin**
9:10	**Research Related to Non-Fish Headwater Streams**	**Timothy Quinn**
9:20	• Drainage Basin Size Related to Stream Origins in Forests of Washington: The Results of the Type N Demarcation Study	Bob Palmquist
9:40	• Low Flow Spatial Characteristics in Forested Headwater Channels of Southwest Washington	Mark Hunter
9:55	• Annual Variation in the Location of Stream Origins in Eastern and Southern Washington	Jim MacCracken
10:05	• A Comparison of Tailed Frog Density Estimation Surveys in Southwest Washington	Timothy Quinn
10:20	**Break**	
10:35	• Amphibian Use of Seeps and Related Headwater Habitats: Implications for a Experimental Study of Headwater Streams	Marc Hayes
10:50	• Dispersion of Coastal Tailed Frog and its Occupancy of Non Fish Bearing Headwater Streams	Marc Hayes
11:05	• Assessing the Effectiveness of Riparian Buffers for Maintaining Microclimate for Amphibians	Ken Risenhoover
11:25	• Effect of Forest Practices on Abundance of Cascade Torrent Salamanders	Jim MacCracken
11:45	**Lunch**	

Time	Topic	Presenter
12:50	**Research Related to Fish Bearing Streams**	**Doug Martin**
1:00	• A Landscape Scale Model to Predict the Upper Limit of Fish Habitat	Brian Fransen
1:20	• Temporal Variability in the Upper Limits of Fish Distribution in Eastern Washington Streams	Mike Cole
1:40	• A Framework for Assessing Distribution and Abundance of Stream-dwelling Bull Trout	Russ Thurow
2:00	• Western Washington Riparian Desired Future Condition Validation Study	Dave Schuett-Hames
2:20	• Using Large-scale Aerial Photography to Evaluate Riparian Timber Stand Characteristics	Rich Grotefendt
2:40	**Break**	
2:55	• A Nomograph for Predicting Water Temperature in Eastern Washington Streams	Domoni Glass
3:10	• Eastern Washington Riparian Effectiveness Study: Stream Temperature, Shade and Solar Radiation - 1st Year Summary for Solar Radiation	Mike Bonoff
3:30	**Research Related to Sediment**	**Jeffrey Clark**
3:40	• Predicting Surface Erosion from Roads in Washington State	Kathy Dube
4:00	• Road Erosion Measurements from the Eastern Cascades	Steve Toth
4:20	• Spatial-temporal GIS Road Sediment Model	Phil Peterson
4:40	• Adventures in Wonderland: The Measure and Meaning of Landslide Rates	Dan Miller

Drainage Basin Size Related to Stream Origins in Forests of Washington: The Results of the Type N Demarcation Study

Author
Dr. Robert C. Palmquist[1]

The Type N Demarcation Study is designed to validate the default basin areas for the break between perennial (Np) and seasonal (Ns) streams in forested headwaters on FFR lands. The pilot phase, which is reported here, was conducted in 2001 to (1) Test a field protocol for collecting field data on Type N streams; and (2) Determine the variability of headwater basin areas to estimate the sample size required to collect a statistically valid sample the statewide survey during a subsequent year. The pilot field protocol was developed in early summer of 2001 and ten field parties using the pilot protocol surveyed over 230 headwater basins across the state in August and September of that year. Comments from the field parties and data analyses indicated the field protocol was suitable with slight modification for the statewide survey. Analysis of the basin areas above the Np/Ns break indicated that the observed basin areas have a log-normal distribution; are smaller than the default basin areas (Table 1); and that to estimate the median basin area within 90% confidence interval and with 10% precision would require a sample of 100 basins per stratification cell, i.e. present default regions are eastside of Cascade crest, westside of crest and coastal zone within the eastside. Study results also included a recommendation to consider average annual precipitation classes as the basis for default regions and distance from the drainage divide to the Np/Ns break as an alternative default measure. The report was submitted to Policy on October 13, 2003.

Table 1: Estimated basin areas above the Np/Ns by FFR default region

SUMMARY STATISTIC ***(in acres)***	***FFR Default Region***		
	Eastside	**Westside**	**Coastal**
Default Area	300	52	13
Sample Size	43	132	18
Average Area	118	24	8
Median Area	36	7	2
1st Quartile Area	9	4	1
3rd Quartile Area	68	24	5
Maximum Area	1,224	260	85

The Np pilot study was the cooperative effort of the Campbell Group, Colville Confederated Tribes, Hoh Tribe, Longview Fibre Co., Port Gamble S'Klallam Tribe, Skagit Tribe, Spokane Tribe, Suquamish Tribe, Washington department of Fish and Wildlife, Yakama Nation and the members of the Upslope Science Advisory Committee, the Np technical group, and CMER reviewers. Their many contributions made this study possible.

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Low Flow Spatial Characteristics in Forested Headwater Channels of Southwest Washington

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Spatial characteristics of late summer (dry season) flow in 21 forested headwater channels in the Stillman Watershed (SW Washington) were collected once in August and September 2001, and three to five times from July to October 2002. The location of the uppermost continuous flow (P_p) and the uppermost pool (P_d) were recorded. Annual differences in the P_d and P_p suggest that the primary control on late summer flow in small headwater basins was spring precipitation and not the typically heavy winter precipitation. Annual and seasonal comparisons suggested that the location of P_d varied considerably less than P_p. In 2002, we collected continuous flow data between P_p and the channel head (P_h). These were used to test alternative hypotheses: (A) flow consistently retreats in a downstream direction, versus (B) flow comes from fixed sources along the channel, and will retreat up-channel towards these sources. The dominant spatial characteristic was increased fragmentation, i.e., mixed dry, saturated and watered channel segments. Short high gradient channels (>30% slope) behaved consistently with Hypothesis B. Longer relatively moderate gradient channels (10% < slope <30%) fragmented without a consistent trend of retreat.

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Annual Variation in the Location of Stream Origins in Eastern and Southern Washington

Author
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Stream origins were located in 1998 and 2001 in eastern, southcentral, and southwestern Washington. In 1998, 149 streams were sampled to inform the Forest and Fish negotiations. In 2001, 119 of those streams were revisited and at 43 details on flow and channel characteristics were also collected as part of a pilot study. The detailed sampling allowed for the classification of origins as perennial initiation points (PIP) or spatially intermittent initiation points (SIIP). 2001 started out as a drought water year and it was hypothesized that stream origins would move downhill relative to 1998 locations. Ninety-two percent of origins moved, with 72% of movements up slope in 2001. Origin movements ranged from 6 – 822 m. Movements were greatest for SIIPs except in eastern Washington. Rainfall at nearby National Oceanic and Atmospheric Administration stations from June-September 2001 was 24% - 165% greater than the same period in 1998. Stream origins, when sampled during the low flow period, appear to be influenced more by immediate, short-term, pre-sampling rainfall events than longer term precipitation trends.

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Comparison of Two Tailed Frog Sampling Methods in Headwater Streams of Southwest Washington

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Annette Hoffman

Methods to sample headwater stream-associated amphibians have been largely based on best professional judgment and tradition. We compared the performance of two stream-associated amphibian sampling methods (rubble rousing versus rapid assessment) to determine abundance of Tailed Frog in the Coast Range of Washington (Stillman Creek watershed) during late summer 2003. We applied the two methods in rapid succession to multiple 1 m bands across 10 streams. Rapid assessment involves searching for individuals in and around easily moved surface objects in the stream and is typically applied to a relatively large proportion of the sample units because of its low relative cost. Rubble rousing on the other hand involves shifting though sediments to a depth of 30 cm (or bedrock) and is typically applied to small proportions of the sampling unit because of high relative cost.

Tailed Frog abundance determined by rapid assessment was not correlated with abundance determined by rubble rousing. Rapid assessment produced biased (low) estimates of tailed frog density but with lower within and across reach variance. However, the bias associated with rapid assessment increased as a function of rubble rousing density. In other words, across a range of densities (determined by rubble rousing), rapid assessment tended to capture a constant number of individuals. This bias renders rapid assessment as an inappropriate sampling method for determining trends in densities through time. Rapid assessment may still be the best sampling approach for determining occupancy of Tailed Frogs because it tends to find frogs in the same areas rubble rousing finds frogs but at a lower cost.

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Amphibian Use of Seeps in Headwater Landscapes

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As part of an adaptive management program for new forest practice rules, we studied physical and vegetative characteristics and amphibian occupancy patterns of seeps, stream reaches, and adjacent uplands in 29 non-fishbearing basins located in managed forestland of southwestern Washington during 2000-2002. Seeps, relatively uncommon features on the landscape, ranged in size from 2-2600 m^2, occurred at densities of 0-1.4/ha and were frequently (> 80%) located ≤ 30 m from stream channels. Seeps had more finer-grained substrates than reaches, and had less tree canopy and more hydrophilic plant species than adjacent upland habitat. Based on a single sampling of basins during the low-flow (August-October) period each year, pre-metamorphic amphibians were significantly less frequent in seeps than in reaches, whereas except for the Columbia torrent salamander, post-metamorphic amphibians were more common in seeps than in reaches. Pre- and post-metamorphic life stages tending to use different habitats suggests that seep presence offers greater habitat options. Torrent salamanders, easily the most abundant headwater amphibian, represented > 60% of amphibians found. Based on non-destructive sampling in 2000-1, all other amphibians were infrequent, but more thorough (albeit disruptive) sampling in 2002 revealed greater amphibian richness and higher abundances of cryptic taxa: lungless salamanders and post-metamorphic giant salamanders and stillwater-breeding amphibians. Amphibian density also varied inversely with seep size, which may reflect seasonal shrinkage of seeps. Repeated within-season sampling will be needed to clarify several patterns, but this approach may require new techniques that help ensure detection without altering habitat.

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Coastal Tailed Frog (*Ascaphus truei*) Dispersion in Headwater Streams: A Hypothesis Indicating Seasonal Movements and its Relationship to Tailed Frog Occupancy of Headwater Streams

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During the low-flow period (August-October) of 2000-2, we recorded the distribution of coastal tailed frog (*Ascaphus truei*) among 131 non-fish bearing stream threads on basalt substrates in the Stillman Creek watershed of southwestern Washington. Older frog life stages were typically found further upstream than younger stages, implying adults move upstream. Seasonal resampling eight streams in 2002 revealed a 400-m upstream shift in the median position of adults from May-June to August-September, which supports this hypothesis. We suggest a cycle in which adults lay eggs downstream, move upstream as low flow approaches, and then return downstream at an unknown time. Frogs likely lay eggs in areas far enough downstream that they do not dry out during low flow, but not so far downstream as to subject weakly mobile hatchlings to scour or drifting passively into predator-rich fish-bearing waters. Adult frogs may move upstream because intermittent headwater reaches have more food. We further found that the likelihood of tailed frog occupying non-fish bearing basins increased with basin size. No tailed frog life stages indicating reproduction (eggs, larvae or metamorphs) were detected in the 30 1st-order basins, which was the smallest size grouping of basins we sampled. Absence of tailed frog reproduction in the smallest basins implies that the length of the non-fish bearing stream thread in these basins may be too short to meet frog habitat requirements. As the abundance of non-fish bearing basins in southwestern Washington is skewed toward the smaller sizes, the constraints we suggest for coastal tailed frog life history will contribute significantly to its pattern of occupancy over this landscape.

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Assessing the Effectiveness of Riparian Buffers for Maintaining Microclimate for Amphibians

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Because of their limited mobility and apparent narrow tolerance for microhabitat conditions, there is concern that amphibians may be negatively impacted by harvest activities in managed forests. Here we summarize preliminary results from investigations of microhabitat conditions in managed forests and relate them to patterns of amphibian occurrence. We measured fine-scale patterns in microhabitat (soil moisture, soil temperature, relative humidity, ambient temperature and vegetation) along transects running perpendicular from the stream edge and extending 60 m into the adjacent upland. We contrasted patterns of microhabitat found in mature (55-65 year old) and recently harvested stands with continuous and discontinuous riparian management zones. Generally, soil temperature was more variable and slightly warmer with increasing distance from streams. Soil moisture was highly variable and showed no consistent trend in relation to distance from streams. Soil moisture was higher in clearcuts than in forested areas. Surprisingly, the range of microhabitat conditions in clearcuts did not differ greatly from those found in riparian buffers or in mature forest stands. Diel patterns of ambient temperature and relative humidity suggested that microclimatic conditions in clearcut and unharvested forests were similar except during 4-6 hours of the mid-afternoon. During July-August, we found that 90% of surface active amphibians occurred within 2m of streams suggesting that protection of near stream microhabitat should be the focus of conservation measures in managed forests. Residual vegetation and woody debris available in clearcuts after harvest appeared adequate to maintain microclimate and refugia for amphibians.

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Effects of Forest Practices on the Abundance of Cascade Torrent Salamanders

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The results of 2 M.S. thesis studies are reported. Craig Steele sampled 34 streams in forests representing a chronosequence of recent harvests through 90+ years old. Regression tree analyses indicated that salamander (*Rhyacotriton cascadae*) abundance was lowest in 0-22 year old stands (0.5/m), greatest in 23-59 year old stands (3-6/m) and intermediate in $\geq$ 60 year old stands (1/m). In addition, salamanders were more abundant in streams with water temperatures $\leq$ 9 C, but water temperature was not related to forest age. Kathleen Pollett sampled streams in recent clearcuts without buffers (10), streams in clearcuts with buffers (12), and stands not harvested (10) to determine if buffers maintained salamander abundance. In addition, air and stream temperature at those sites was sampled every ½ hour from early July-late October. Salamander abundance was 0.2/m in streams without buffers, and 0.5/m in buffered and no harvest streams. A confidence interval analysis, based on raw effect sizes, indicated that buffers maintained salamander abundance. The correlation between buffer width and salamander abundance was –0.40, but more data is needed to accurately describe this relationship. Air temperatures were greatest ($P = 0.0001$) (24 C) and lowest (8 C) in clearcuts, followed by buffers (20 and 10 C), then no harvest stands (17 and 10 C). However maximum and minimum water temperatures averaged 11 and 10 C, respectively, for all streams. Clearcut harvest appears to reduce salamander abundance, but populations recover by mid-rotation, and buffers appear to ameliorate the sort-term effect of clearcut harvest. Salamanders are more abundant in streams with temperatures between 7-9 C, and air temperature had a small effect on water temperature.

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A Landscape–Scale Model to Predict the Upper Extent of Fish Habitat

Author
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Regulations intended to provide protection of aquatic resources in Washington State distinguish between fish habitat and no fish habitat waters. The Forest and Fish Report prescribed a new system that relies on a GIS-based model to determine fish habitat classification. The model is field data driven, and is intended to provide high classification accuracy and balance between economic and aquatic resource considerations. Available field survey data collected at the upper limit of fish habitat across western Washington was used to develop and assess a preliminary model. Stream characterization data was derived from USGS Digital Elevation Models, and included drainage area, stream gradient, elevation, and precipitation. A logistic regression model incorporated these variables to assign a likelihood of fish habitat presence within streams. A heuristic rule further refined the model prediction to a single break point. Due to the non-random nature of the available survey data, model precision, accuracy and balance across western Washington could not be reliably characterized. Largest model errors were usually associated with natural barriers, headwater lakes, or stream reaches with intermediate model probability. Opportunities exist for use the model as a screen to identify areas with highest likelihood of error.

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Temporal variability in the upper limits of fish distribution in eastern Washington streams

Authors
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Streams were surveyed throughout ten forested watersheds in eastern Washington in the summer of 2001 and again in 2002 to examine inter-annual variability in the upper extent of fish distribution. In 2002, resurveys of 308 streams were performed, during which172 terminal points (occurring mid channel or at the confluence of non-fish-bearing streams) and 136 lateral points (where a non-fish-bearing channel laterally intersects a fish-bearing channel) were established. Differences between 2001 and 2002 terminal last fish points were evenly distributed among upstream shifts, no change, and downstream shifts from 2001 locations. Excluding two relatively large downstream shifts, the mean distance between 2002 and 2001 terminal last fish points was -2.5 m. Terminal last fish locations most often occurred immediately below small impasses created by large woody debris. All but two of 134 streams established as lateral points in 2001 were again found to support no fish. Our data indicate that the upper extent of fish distribution was similar between these two years, but further investigation is needed over longer time periods and a wider range of climatic and streamflow conditions to better characterize temporal variability in last fish locations.

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A Framework for Assessing Distribution and Abundance of Stream-dwelling Bull Trout

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Effective conservation and restoration strategies require reliable approaches for assessing the distribution and abundance of stream-dwelling fishes. The probability of detecting fish depends on the capture efficiency of the selected method (ability to capture fish) and the abundance of fish (number of chances). As a result, detection can be estimated for any method provided estimates of abundance and capture probabilities are available. Here we describe results of research to estimate detection probabilities by modeling sampling efficiencies of commonly used methods for sampling stream-dwelling bull trout. We demonstrate how detection probabilities can be applied to estimate required sample sizes, interpret observed absences (zero catches), and how this information can be incorporated into decision-making and adaptive management.

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Western Washington Riparian Desired Future Condition Validation Study

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The purpose of this study is to validate the Desired Future Condition (DFC) targets used to regulate timber harvest within conifer-dominated riparian management zones (RMZs) along fish-bearing (Type F) streams in western Washington under the state forest practices rules. The DFC targets are expressed in basal area per acre and are intended to represent stand conditions in unmanaged mature riparian forests. The targets vary by site class. When landowners propose to harvest timber from the inner zone of an RMZ they are required to conduct an inventory of the stand and use a model (the DFC model) to predict tree growth and mortality to stand age 140 years. If the projected basal area at age 140 years exceeds the target then harvest of 'excess' basal area is allowed, while if it is below the DFC target no harvest is allowed. There is scientific uncertainty about the targets currently in use due to the limited amount of existing data available to characterize mature, unmanaged riparian stand conditions. To address this issue, data were collected from a random sample of 113 mature (80-200 year old) conifer-dominated western Washington riparian stands. Plots were 164 ft long and varied in width to match the combined widths of the core and inner zones of the regulatory RMZ for each site as defined by site class. Each plot was adjacent to a stream or channel migration zone and was dominated by conifer trees between 80 and 200 years of age with no evidence of past timber harvest. Sampling was stratified by site class so the DFC target for each site class could be compared to sites with similar growing conditions. The study results indicate:

- There was a discrepancy between the site class indicated on maps and estimates derived from field measurements at 74% of the sites. The field site class measurements indicated higher site quality than the map site class in the majority of cases (59%).
- Mean live conifer basal area per acre was greater than the existing DFC performance target values for all site classes. The differences were statistically significant at $P < 0.01$.
- Mean basal area per acre decreased with declining site quality but the differences between site classes were not statistically significant. No pattern was evident between basal area per acre and map-based site class, likely due to the unreliability of the site class maps.
- Site and stand attributes explained little of the variability in basal area per acre. Only 3 of 16 independent variables (dominant tree species, precipitation and site index) had significant relationships with live conifer basal area per acre. The difference in live conifer basal area per acre between stands dominated by Douglas-fir and western hemlock was significant but sample size was not large enough to test for differences among other stand types.
- None of the eight alternative parameters evaluated appeared to be clearly superior to basal area per acre as a measure of mature stand condition. Volume per acre appeared useful in distinguishing mature stands from younger, harvest-age stands because it integrates tree height, diameter and density. Use of a measure that integrates trees per acre and quadratic mean diameter may merit further investigation.

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Using large scale aerial photography to evaluate riparian timber stand characteristics

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The monitoring of riparian timber stand characteristics is becoming increasingly important in the adaptive management of forests and aquatic resources. The effectiveness of prescriptions to maintain important ecological functions provided by riparian forests is an important component of adaptive management. Monitoring programs must facilitate measurements of key processes and functions in different ecotypes. Repeatable and cost-effective methods are needed to measure varying stand and ecological characteristics such as tree height, species, down tree length, and position relative to the stream. A fixed-base camera system was developed to collect large scale photography (1:2,000) for the purpose of studying buffer zone characteristics in Alaska and Washington. This system was recently implemented as a replacement for field collection because it provides detailed 3D views of standing and down trees as well as a medium for their measurement. The system also allowed key characteristics to be determined such as decay class that allowed identification of the timing of mortality and recruitment processes (e.g. bank erosion versus windthrow) that allowed identification of the cause of mortality. The system was implemented for an extensive sampling program that included 1,700 photo pairs from 52 km of streams in Alaska and 108 photo pairs from 36 streams in Washington. The method facilitated a stratified random sampling study design in both cases. Validation sampling showed that the system measurement errors range from 0.2 to 1.8 percent horizontally and 1.2 to 2.6 percent vertically on a control field. In Alaska the use of large scale photography enabled detection of a significant reduction in stand density, stand mortality differences between logged and unlogged units, and the localization of mortality on the outer edge of the buffer. Analysis of the Washington data is still ongoing.

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A Nomograph for Predicting Water Temperature in Eastern Washington Streams

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In 1992, the Washington State Forest Practices Board (FPB) adopted forest practices regulations in an effort to bring forest practices rules into compliance with State Water Quality Standards. Included in these regulations were state-wide temperature prediction nomographs that were designed to assist landowners, other interested parties and federal, state, and tribal agencies in determining proper shade levels to be maintained along streams to protect stream temperature. These nomographs used elevation and shade as the predictors for stream temperature. In 1993, separate temperature prediction nomographs were developed for eastern Washington conditions. The temperature prediction nomographs that were developed in the 1990s were specific to the State Water Quality Standards of 16.0 ^{o}C for Class AA (extraordinary water quality) streams and 18.0 ^{o}C for Class A (excellent water quality) streams. The eastern Washington nomographs were subsequently incorporated into the new forest practices rules adopted in May, 2001. At the time of their adoption into the new rules, a need to update the eastside nomographs with additional information was identified. This project addresses that need.

Existing stream temperature data was collected from a agencies, tribes, landowners, and others. All data used in the analyses needed to include at least a measure of summer maximum temperature, canopy closure, and a site location and/or elevation. Additional data was for each site was also requested where available. This additional data included stream flow, bank full width and depth, drainage area, annual precipitation, hillslope gradient distance to the watershed divide, channel aspect, and air temperature. The additional data was available for only a handful of sites. GIS analysis and existing GIS coverages were used to estimate values for all these attributes except stream flow and bank full width and depth. Regression analyses were conducted to identify the independent variables that had the greatest effect on stream temperature and to develop equations that could be used to develop updated eastern Washington nomographs. Data analyses were stratified by geographic region, ecoregion, and lithology.

In many cases, the strength of the relationships developed was affected by sample size or the distribution of available samples across the independent variables. In the Blue Mountains, location was not available; hence the GIS based variables could not be derived.

The majority of the regression equations found canopy closure and either basin size or distance from divide as the primary variables explaining the variance in stream temperature in each strata. Earlier studies conducted in the 1990s also found distance from divide to be a primary driving variable. The results suggest a primary relationship between stream temperature and stream flow, which is modified by canopy closure. This study is not yet complete and the results have not been reviewed.

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Effectiveness of the Current TFW Shade Methodology for Measuring Attenuation of Solar Radiation to the Stream

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In 2003, the Bull Trout Scientific Advisory Group, of the Forests and Fish Cooperative Monitoring, Evaluation and Research adaptive management program, implemented two connected studies designed to determine the effectiveness of the two eastern Washington riparian shade prescriptions in maintaining stream temperature. This presentation summarizes the methodology and the first field season of one of these studies: Effectiveness of the Current TFW Shade Methodology for Measuring Attenuation of Solar Radiation to the Stream. This study focuses on the effectiveness of the "all available shade" prescription that requires retention of all trees that contribute shade to fish-bearing streams within 75 feet of the stream, within the bull trout overlay area that identifies known and potential bull trout habitat. The primary working hypothesis for this study is that there is no significant difference in solar energy reaching the stream pre- and post-harvest when the "all available shade" rule is applied. Nine of 20 stream sites included in this study were surveyed in the summer of 2003. Adjoining reference and treatment reaches (300 meters each) were established on each stream, and solar radiation data were collected at 50 meter intervals by a 2-man crew working simultaneously within each reach. A mobile data collection approach was developed in which crews moved from station to station over the course of a single day, logging data for 5-8 minutes at each station. This resulted in 6-7 loops within each of the treatment and reference reaches over the course of a day. To ensure symmetry around solar noon, the timing of data collection was pre-programmed based on known solar elevations at a particular site. Solar radiation data collected within treatment and reference reaches were compared to data collected with the same type of instrumentation at a nearby, unobstructed hilltop site. Ratios of percent available radiation (PAR) were then developed for data collected at treatment and reference reaches. Average PAR for all sites sampled in 2003 ranged from 3 to 16 percent. Results from this solar portion of the study will be analyzed along with shade (densiometer), hemispherical photography, stream temperature, and riparian stand measurements conducted as part of the larger study.

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Predicting Surface Erosion From Roads in Washington State

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Erosion from forest roads can be a large source of sediment in watersheds managed for timber production. Timberland owners and tribal, state, and federal resource managers cooperatively developed empirical methods to quantify road surface erosion as part of the Washington DNR's Watershed Analysis Methods in the 1990's. Since that time, these methods have been further refined and integrated into a GIS model (SEDMODL) developed by Boise Cascade and the National Council for Air and Stream Improvement. The DNR and the UPSAG working group of CMER have further adapted the road erosion calculations into an updated Washington Road Surface Erosion Model (WARSEM). The goals of the WARSEM project have been to provide users with a standardized, repeatable method to estimate road surface erosion and sediment delivery to channels that can be used for monitoring and assessing achievement of CMER performance targets.

The Washington Road Surface Erosion Model is a database tool that allows users to estimate average annual road surface erosion and sediment delivery to channels in a standardized manner using empirical relationships between road characteristics and sediment production. The model is intended for use on forest roads in Washington State, and can be applied on a variety of scales, ranging from a single road segment to all roads within a watershed. The model is designed to interface with a GIS system if such spatial data information are available. The analysis can be carried out at 4 different levels, depending upon the purpose of the analysis and the level of detail of data available for the roads:

Level 1 – Screening. Assessment tool for determining relative sediment input using little site-specific information. Useful for screening road system to prioritize field work.

Level 2 – Planning-level Assessment. Assessment of erosion and delivery appropriate for use during road maintenance planning or sediment budgeting using minimal site-specific information.

Level 3 – Detailed Assessment and Scenario Playing. Detailed assessment of erosion/delivery using field-verified data on each road segment. Ability to determine reduction in sediment delivery resulting from potential road maintenance or Best Management Practices (scenario playing).

Level 4 – Site/Segment Level Monitoring. Ability to track changes in road segment attributes and erosion/delivery resulting from road maintenance or BMPs through time. The user has the ability to update and track road records as new information for the roads becomes available as a result of field inventories or improvements from maintenance or BMPs. Users can specify past, present, or future dates for calculation, allowing resource managers to estimate changes in road surface erosion through time in response to alternative road management activities.

The manual provided with the model provides standardized field protocols to help users collect data on roads in a consistent manner. Testing of the field protocols using un-trained observers suggested that training of field personnel is important if consistent, repeatable results are desired. Based on an analysis of sensitivity, the most care should be taken in determining road age, traffic use, surfacing, road width, and runoff/delivery characteristics.

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Road Erosion Measurements from the Eastern Cascades

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The purpose of this study was to measure sediment production and particle sizes from road erosion under the snowmelt-dominated conditions of the east Cascade Range and to compare these results with sediment yield from other road erosion studies. These data were used to evaluate the Washington State watershed analysis model for road sediment production. Results indicate that road erosion for eastside Cascade conditions is less than most other areas of the Pacific Northwest, but generally of the same order of magnitude. The data also indicate that the road erosion model from watershed analysis in some cases does not provide estimates of road sediment production consistent with the scientific literature. The particle size distribution of eroded sediment in this study was coarser than reported by other researchers. Sand-sized sediment eroded from native surface roads may have a greater opportunity to negatively impact the quality of spawning gravel than previously suspected.

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Simpson Road Sediment Model: a Tool for Informing Operational Decisions

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Simpson Resource Co. is pursuing the development of an empirically driven GIS based road sediment model. The purpose of the model is to quantify the amount of sediment derived from our roads to the channel network and assist our logging managers in making decisions about wet weather haul, road maintenance and remediation activities, and timber harvest unit scheduling. Building blocks of the model are: area specific rainfall records, road response class excess runoff relationships, ownership wide road inventories, sediment rating curves for varying levels and types of traffic, timber harvest plans, customer based log haul routes and Simpson's total maximum daily load allocation (TMDL) for sediment. Progress on model components to date includes the establishment of rainfall databases, development of unit hydrographs, collection of road inventory data, collection and processing of sediment samples, determination of traffic patterns and travel rates, and scoping of the user interface and GIS components. Excess runoff relationships have been described using road infiltration capacities and instantaneous unit hydrographs. While each road segment responds differently to precipitation and winter soil moisture, excess runoff relationships can be generalized to our road inventory and describe patterns of excess runoff sufficiently for model purposes. For the same road segment, sediment concentrations in runoff water differ more than an order of magnitude between heavy haul periods and periods of temporary non-use. Road surfaces flush of fines within several hours of cessation of heavy haul. Integration of all model components into the GIS and development of the user interface is anticipated during 2004.

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Adventures in Wonderland:
The Measure and Meaning of Landslide Rate

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Landslides are recognized as an intrinsic and important component in the suite of processes driving ecosystem function in landscapes with steep terrain. The consequences of a single landslide are fairly obvious, particularly local to the event in space and time. The deleterious effects of landsliding and the apparent propensity for management activities to trigger landslides have spurred efforts to identify landslide-prone terrain. Regulation of activities in such terrain has also, appropriately, motivated efforts to discern the results of these efforts. Yet, because landslides are naturally distributed unevenly in space and time, it can be difficult to relate variation in landslide rate to changes in management. As yet, such relationships have not been empirically established. I will discuss the challenges faced by such efforts and describe factors important to design of monitoring studies intended to identify differences in landslide rate. I'll report on results from several studies that look at measures of landslide rate in relation to forest type and the presence of forest roads. In particular, I'll look at how measures of landslide rate are affected by the scale over which measurements are made and the manner in which landslides are mapped (on the ground or from aerial photographs). It is important to identify the factors that influence measures of landslide rate, such as spatial variation in topography, temporal variation in landslide-triggering storms, bias in landslide mapping, and the time and area over which mapping is done, because these all affect the replicability of such measures and the confidence to be placed in study results. I'll show how spatial heterogeneity and mapping bias might be quantified and how confidence in measured landslide rates can be estimated as functions of the spatial and temporal extent over which measurements are made.

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